MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

EPM4086 – DIGITAL CONTROL SYSTEMS

(RE)

14 MARCH 2018
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 4 Questions only.
2. Attempt **FOUR** out of **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. Table of Transform Pairs has been included in Appendix.

Question 1

(a) What are the two important s-plane properties of starred transform? [5 marks]

(b) For the following z-transform,

$$F(z) = \frac{0.792Z^2}{(Z-1)(Z^2-0.416Z+0.208)}$$

(i) Analyze how the final value theorem can be applied to the above equation. [5 marks]

(ii) Analyze part (i) by using power series to expand the function $F(z)$. [5 marks]

(c) Given that $h(k) = 0.06(0.96)^k; k \geq 0$ and $r(k)$ is the unit-step sequence. Determine the output $y(k)$. [10 marks]

Question 2

(a) The Nyquist criterion is a graphical method of testing the stability of a closed-loop system from the polar plot of the loop transfer function. The closed-loop transfer function of a Single Input Single Output (SISO) digital control system is

$$M(z) = \frac{C(z)}{R(z)} = \frac{G(z)}{1+GH(z)}$$

The stability of the system is examined by investigating the zeros of the function $\mathbf{1} + \boldsymbol{GH(z)}$. What are the three steps of Nyquist criterions for $\boldsymbol{GH(z)}$? [5 marks]

(b) Consider the following discrete characteristic equation

$$F(z) = z^3 + 3az^2 + 2az - 0.6$$

(i) Find the range of a such that $F(z)$ satisfies the the preliminary Jury Test. [5 marks]

(ii) What is the condition of stability? [5 marks]

Continued ...

(c) For the sampled-data system shown in Figure Q2, find the output $y(k)$ when the input is unit step (T = 1sec) with $G_P(s) = \frac{1}{(s+1)}$. [10 marks]

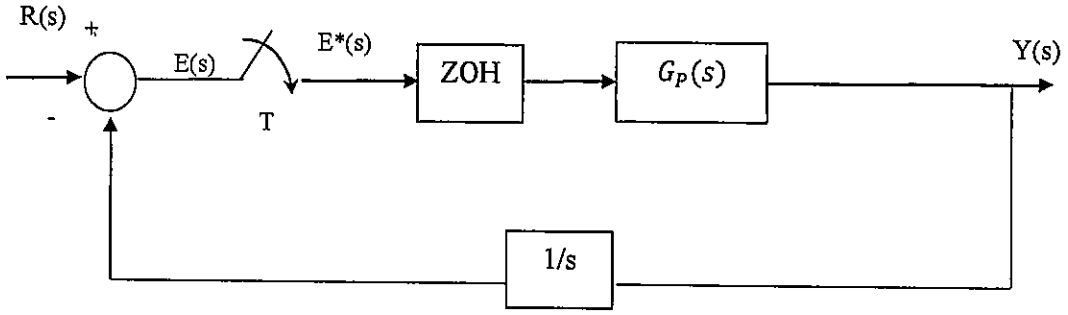

Figure Q2

Question 3

(a) Explain Luenberger State Observer with the help of a block diagram. [10 marks]

(b) The input-output transfer function of a digital control system is

$$C(z) = \frac{1.85(z + 0.1)}{z^3 + 0.8z^2 + 0.13z + 0.006}$$

Design a system so that it is state controllable but not observable. [6 marks]

(c) Redesign the system as shown in Figure Q3 such as the system is controllability and observability. [9 marks]

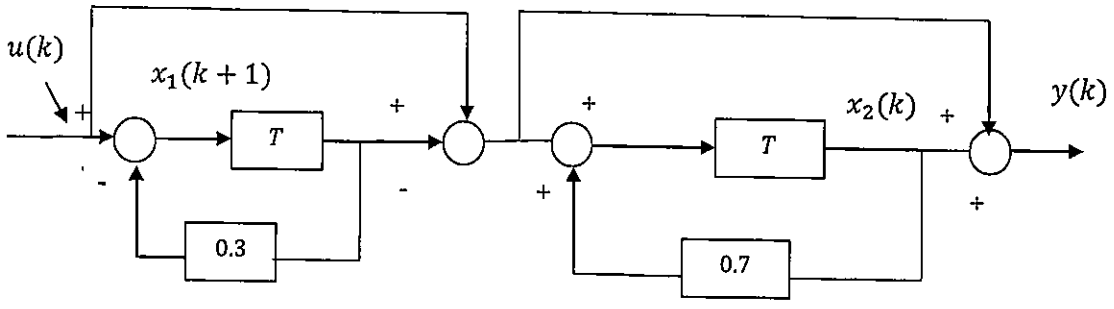

Figure Q3

Continued ...

Question 4

(a) Determine the state and output equations for the following difference equation, where the input is $u(k)$ and the output is $y(k)$

$$y(k+3)+3y(k+2)+3y(K+1)+y(k)=11u(k)$$ [12 marks]

(b) Given a system $x(k+1)=Ax(k)+Bu(k);\ c(k)=Dx(k)$

where, A$=\begin{bmatrix}0 & 1\\ -4 & -6\end{bmatrix}; B=\begin{bmatrix}0\\1\end{bmatrix}; D=[1\ -2]$

The control is realized through state feedback, $u(k)=-Gx(k)=-[g_1, g_2]x(k)$. Where $g_1$and g_2 are real constants. Design the values of $g_1$and g_2 for the system to be completely observable. [13 marks]

Continued ...

APPENDIX

TABLE OF TRANSFORM PAIRS

Time function $f(t); t > 0$	Laplace Transform $F(s)$	Z-transform $F(z)$, T = Sampling time
$u_s(t)$	$1/s$	$z/(z-1)$
t	$1/s^2$	$Tz/(z-1)^2$
t^2	$2/s^3$	$T^2 z(z+1)/(z-1)^3$
ε^{-at}	$1/(s+a)$	$z/(z-\varepsilon^{-aT})$
$1-\varepsilon^{-at}$	$a/\{s(s+a)\}$	$z(1-\varepsilon^{-aT})/\{(z-1)(z-\varepsilon^{-aT})\}$
$t\varepsilon^{-at}$	$1/(s+a)^2$	$Tz\varepsilon^{-aT}/(z-\varepsilon^{-aT})^2$
$\sin at$	$a/(s^2+a^2)$	$z\sin aT/(z^2-2z\cos aT+1)$
$\cos at$	$s/(s^2+a^2)$	$z(z-\cos aT)/(z^2-2z\cos aT+1)$
$\varepsilon^{-at}\sin bt$	$b/\{(s+a)^2+b^2\}$	$z\varepsilon^{-aT}\sin bT/(z^2-2z\varepsilon^{-aT}\cos bT+\varepsilon^{-2aT})$
$\varepsilon^{-at}\cos bt$	$(s+a)/\{(s+a)^2+b^2\}$	$(z^2-z\varepsilon^{-aT}\cos bT)/(z^2-2z\varepsilon^{-aT}\cos bT+\varepsilon^{-2aT})$

End of Paper